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Ingenika Elk Transplant: Monitoring and Evaluation

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The Peace/Williston Fish & Wildlife Compensation Program is a cooperative venture of BC Hydro and the provincial fish and wildlife management agencies, supported by funding from BC Hydro. The Program was established to enhance and protect fish and wildlife resources affected by the construction of the W.A.C. Bennett and Peace Canyon dams on the Peace River, and the subsequent creation of the Williston and Dinosaur Reservoirs.

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ABSTRACT

In February 1996, the Peace/Williston Fish and Wildlife Compensation Program (PWFWCP) translocated 50 elk to the lower Ingenika River drainage to supplement the small existing elk population. Ten of the transplanted adult females were fitted with motion-sensitive radio collars. Twelve seasonal radio-telemetry elk monitoring flights were conducted from February 1996 to March 1998 to monitor the movements, seasonal habitat use, and mortality rate of collared elk. Of the 10 radio-collared elk, 4 expressed fidelity to range in the vicinity of the release site, 2 established home ranges nearly 20 km from the release site, one emigrated from the lower Ingenika River area, and 3 died during the monitoring period.

A mark-resight total-count population inventory of the Ingenika elk herd was conducted in February 2000. The survey resulted in a conservative population estimate of 34-62 animals, slightly below the expected estimate of 65 animals based on the actual age/sex ratio of the transplanted animals (Wood 1998a). The desired objective of establishing a population of 100 elk 4 years after the transplant was not met, however, this was due in part to the actual age/sex ratio of the transplanted elk (Wood 1998a). Intraspecific resource competition and/or high natural mortality may be limiting factors. A prescribed burn planned for the Ingenika area is expected to benefit resident elk by increasing early seral forage areas.

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1.0 INTRODUCTION

Once the most widespread members of the deer family in North America, elk (*Cervus elaphus)* in British Columbia (BC) experienced dramatic declines in number and distribution throughout the 1800s (Spalding 1992), largely due to excessive harvests and human settlement activities (Demarchi et al. 1992). In BC, population management, milder winters, and an increase in early seral forage areas (resulting from logging and forest fires) have stimulated elk range expansion and population growth in this century (Child 1988, Demarchi et al. 1992, Ritchie 1992, Spalding 1992). In the early 1990's, the provincial elk population was estimated at 36,325 animals (Demarchi et al. 1992).

There are two native sub-species of elk in BC today: Rocky Mountain elk (*C.e. nelsoni*) in the interior, and Roosevelt elk (*C.e. roosevelti*) on the south coast (Demarchi et al. 1992, Spalding 1992). The largest Rocky Mountain elk populations occur in the Kootenay region of southeastern BC, with smaller populations in the BC interior (Demarchi *et al.* 1992). In northern BC, there are approximately 6,200 Rocky Mountain elk (Child 1988), with an estimated 250 to 300 elk in the Omineca administrative region (Ritchie 1992). Within the Williston Reservoir watershed, there is a thriving elk population on the north shore of the reservoir's Peace Reach (the result of a transplant in the mid-1980s), and small populations in the Ospika, Ingenika, Akie, Pesika, and lower Finlay River drainages (Davidson and Dawson 1990; Spalding 1992; PWFWCP, data on file). Sightings of elk in the Anzac River drainage, Omineca River drainage, and between Mackenzie and Finlay Bay, have also been documented (PWFWCP, data on file).

The small number of elk residing in the Ingenika River area on the west side of the reservoir's Finlay Reach is believed to be an isolated, relic population which survived the declines of the last century (Child 1988); there was a small population of elk in this river valley at the turn of the century (Spalding 1992). A herd of about 50 elk was reported in the Ingenika River valley in 1971, and 20-30 elk were sighted near Ingenika River in July 1977 (Spalding 1992). The population has been estimated at 30-50 animals and appears to have been increasing slowly over the last 25 years (Demarchi et al. 1992, Ritchie 1992, Spalding 1992). Supplemental elk transplants were suggested to further stimulate population growth in this area (Demarchi et al. 1992).

At least 21 elk translocations have been conducted in BC since the early 1900s (Spalding 1992). Transplants have successfully established or augmented populations throughout the province, including two locations in the boreal and sub-boreal interior: 131 elk were translocated in 1984 and 1985 to the Kechika River valley in northern B.C. (Ritchie 1992, Spalding 1992), and 145 elk were translocated in 1985 and 1987 to Little Dunlevy Lake on the north shore of the Williston Reservoir's Peace Reach (Spalding 1992; Backmeyer 2000).

In February 1996, the Peace/Williston Fish and Wildlife Compensation Program (PWFWCP) translocated 50 elk from the Chetwynd area to the lower Ingenika River drainage to supplement the small existing elk population (Wood 1993, Wood 1998a). It was originally anticipated that a new population of approximately 70 elk (50 transplanted + 20 residents) would increase to 100 animals in 4 years, based on a conservative growth rate of 10% (Wood 1998a). This figure was subsequently revised to approximately 65 elk in 4 years based on the actual age/sex ratio of the transplanted animals (Wood 1998a). Ten of the transplanted adult females were fitted with motion-sensitive radio collars to enable subsequent monitoring of the herd, while the remaining elk were marked with coloured nylon neck bands or ear tags.

Subsequent to the transplant, the PWFWCP conducted tracking flights to monitor the radio-collared elk. The monitoring objectives were 1) to assess the movements of collared female elk immediately after the release, and the subsequent establishment of home ranges, 2) to provide an indication of seasonal elk habitat use, and 3) to monitor the mortality rate of collared female elk. To gauge the success of the transplant, a population inventory was conducted in February 2000. This report documents the results of the radio-telemetry monitoring February 1996 - March 1998, and the February 2000 population inventory.

2.0 STUDY AREA

The Ingenika River is a tributary to north central BC's Williston Reservoir, flowing east from the Omineca Mountains into the reservoir's Finlay Reach (Figure 1). The river valley lies within the dry, cool Boreal White and Black Spruce (BWBSdk1) biogeoclimatic zone, extending from the reservoir at 670 m to 1,100 m in elevation (MacKinnon et al. 1990). Climax forest canopies within this subzone are comprised of white spruce (*Picea glauca*) and lodgepole pine (*Pinus contorta*), with black spruce (*Picea mariana*) sometimes occurring in the main canopy on upland sites.

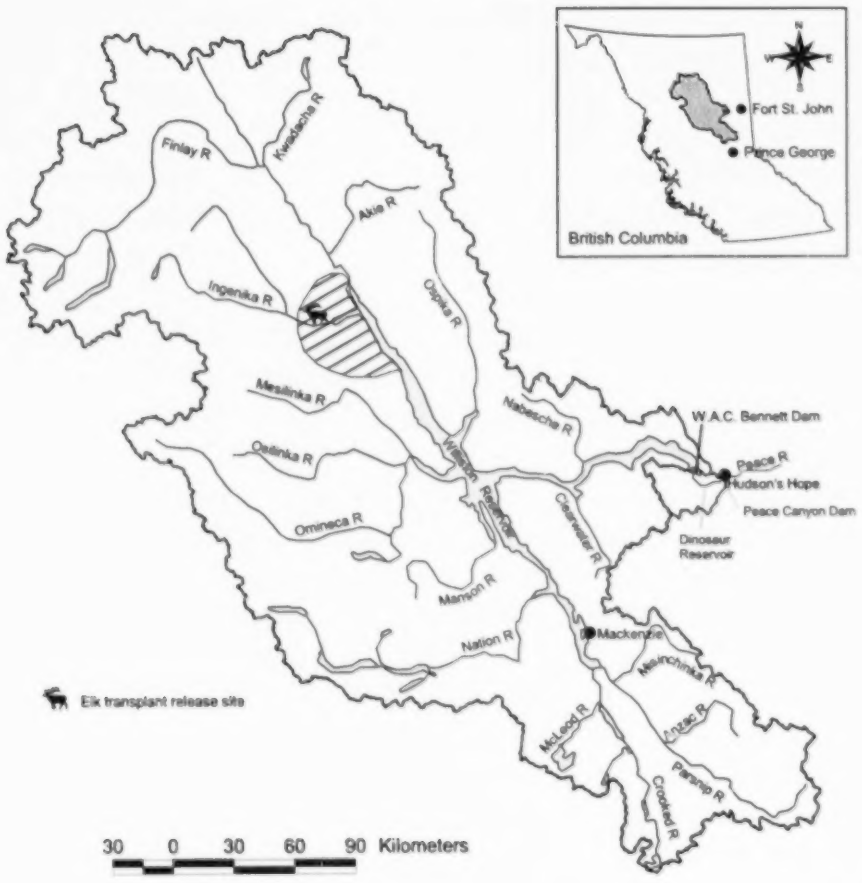

Figure 1. Release site and study area for the 1996 Ingenika River elk transplant (Williston Reservoir watershed, north central British Columbia).

At higher elevations (1,000 – 1,500 m) the BWBSdk1 is replaced by the moist, very cold Engelmann Spruce - Subalpine Fir (ESSFmv4) and the Spruce-Willow-Birch (SWB) biogeoclimatic zones. The ESSFmv4 subzone characterizes subalpine portions of Mount Isola and Chase Mountain, and the east slope of Mount Ross (BC Environment 1998). Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) predominate, with some lodgepole pine and black spruce present on poorer and fire-influenced sites (DeLong et al. 1994). The north- and west-facing slopes of Ingenika Cone and Mount Ferguson are characterized by the relatively open forest canopies of the SWB zone, typically dominated by white spruce with some subalpine fir (MacKinnon et al. 1990, BC Environment 1998). Lodgepole pine and, to a lesser extent, trembling aspen (*Populus tremuloides*) may be present in younger stands (MacKinnon et al. 1990). Alpine Tundra (AT) occurs above 1,500 m (MacKinnon et al. 1990).

The lower Ingenika River valley is climatically dry, with an extensive fire history and relatively low snow depths. In 1958, a large, patchy fire burned portions of the study area east of Delkluz Lake, including Ingenika Cone and the sidehill along the lower Ingenika River (present-day Ingenika Arm) (Ministry of Forests 1990). In 1970, a substantial fire burned an area roughly 250 km^2, between Delkluz Lake and Ingenika Crag (locally known as 'Grassy Bluff') on the east and Cutbank Creek to the west. Much of the area is now dominated by early seral stages of aspen and young pine, with some older stands of pine, spruce, and aspen. Small, patchy fires in 1984 and 1985 burned portions of the sidehill north of the lower Ingenika River and Ingenika Arm.

Mean annual snowfall in the lower Ingenika River valley (BWBSdk1 subzone) is 180 cm (range 135-270 cm) (MacKinnon et al. 1990). Snow depth surveys in 1990 and 1994 identified low to moderate accumulations of 40-80 cm along the lower Ingenika River and sidehills of the Ingenika Arm and Ingenika Cone, indicating potential moderate to high ungulate winter range capability (Martin 1994; PWFWCP, data on file).

The elk transplanted to the area in 1996 were released near Ingenika Crag on the north side of the Ingenika River, approximately 9.5 km upstream from the river's delta at the Williston Reservoir's Ingenika Arm (Figure 2). South facing slopes (700 m to 1,200 m elevation) near Ingenika Crag and the lower Ingenika River valley provide the main winter range for the local elk population. Mountainous summer range exists north and west of this area.

For report purposes, the study area is subdivided and referenced as follows (Figure 2):

Ingenika Sidehill — includes the valley bottom riparian zone along the north side of the Ingenika River and the south-facing slopes (700 m to 1,200 m elevation) from Ingenika Crag east to lower Isola Creek at the reservoir's Ingenika Arm. The river is meandering, with oxbows, backchannels, and a wide floodplain. Portions of the sidehill were subjected to a wildfire in 1970; thus early seral stages of aspen and pine predominate, with older patches of pine, spruce, or aspen near the riparian zone.

Delkluz Flats — the flat, lodgepole pine dominated area around Delkluz Lake, between the Ingenika and Swannell Rivers. Black spruce and some trembling aspen are also present. A wildfire burned portions of this area in 1958.

Ingenika Cone — the north- and west-facing slopes of the Ingenika Cone area (i.e., north end of the Butler Range), from the Swannell River east to Flood Creek and from the Ingenika River south to Ravenal Creek. Lodgepole pine predominates, with some spruce and aspen along the Swannell River. Much of this area was subjected to a wildfire in 1958.

Frank Creek — the north- and east-facing slopes adjacent to the Williston Reservoir, east of Flood Creek, and south from the Ingenika Arm to Frank Creek. Intensive forest harvesting since the mid-1970s has resulted in numerous clearcuts on the lower east-facing slopes adjacent to the reservoir. The remaining mature forest is primarily lodgepole pine, spruce, and aspen, with subalpine fir at higher elevations. A wildfire in 1958 burned lowland areas along the Ingenika Arm.

Any locations outside these areas are noted with reference to the nearest recognizable geographic feature.

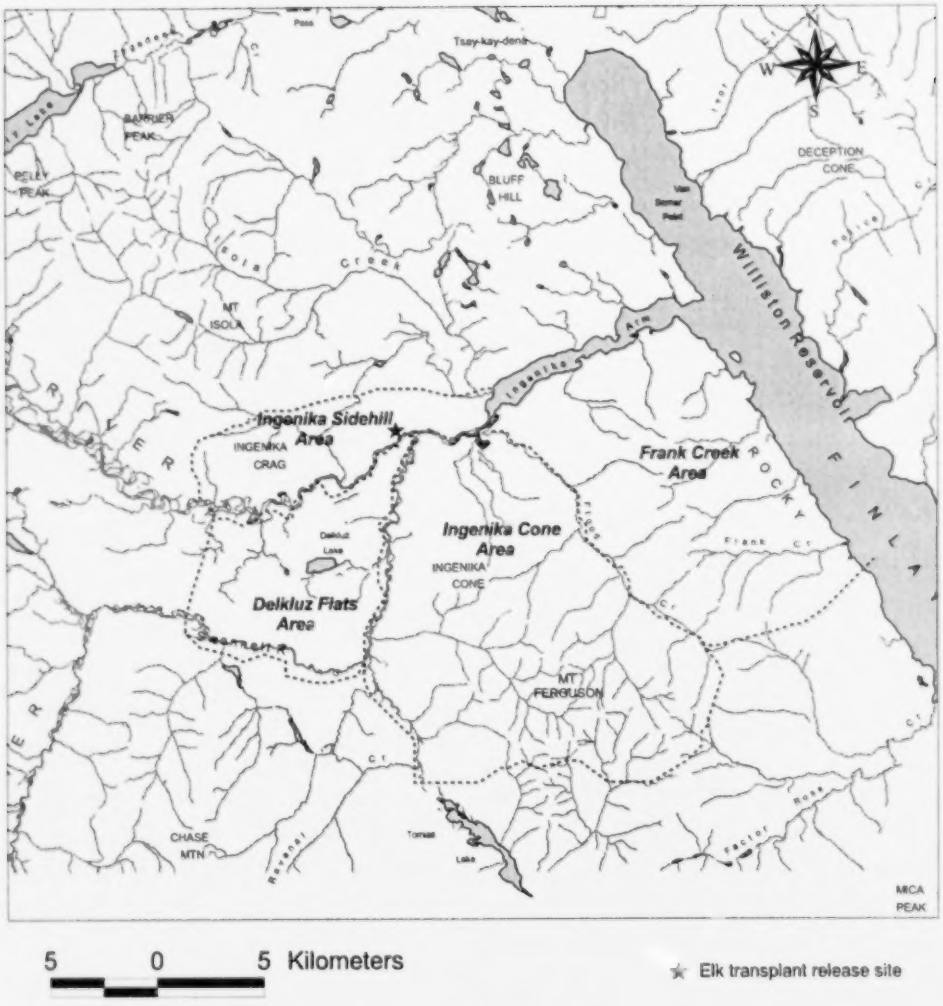

Figure 2. Elk transplant release site along the Ingenika River, February 1996. For purposes of this report, the surrounding areas are referred to as Ingenika Sidehill, Delkluz Flats, Ingenika Cone, and Frank Creek.

3.0 METHODS

3.1 Monitoring of radio-collared elk

To enable subsequent monitoring and identification of transplanted animals, elk translocated to the Ingenika River area between 20 and 27 February 1996 were collared with Lotek LRMT-4 radio-transmitters (Lotek Engineering, Newmarket, Ontario), or tagged using a numbered nylon orange or yellow neck band, or a numbered green ear tag (Table 1; Wood 1998a).

Table 1. Age, sex, and identification of elk transplanted to the Ingenika River area, 20 to 27 February 1996 (from Wood 1998a).

Tag method	Age and sex classification[a]				Total
	Af	Am	Cf	Cm	
Radio-collar	10[b]				10
Orange nylon neck band	9	1	1		11
Yellow nylon neck band	11	1	2		14
Green ear tag		2	5	8	15
Total	30	4	8	8	50

[a] Age and sex classification: A (Adult), C (Calf), f (female), m (male).
[b] One radio-collared female was also ear-tagged.

Two surveys were conducted within 2 weeks of the release to assess the status of radio-collared elk. Subsequent radio-telemetry monitoring flights were conducted seasonally over a 2 year period: 1996/97 (1 Apr 1996 - 31 Mar 1997) and 1997/98 (1 Apr 1997 - 31 Mar 1998). For each year, the intent was to conduct flights at least once per season: spring (1 April to 15 May), calving (15 May to 15 June), summer (15 June to 1 September), fall rut (1 September to 31 October), and winter (1 November to 1 April). All monitoring was accomplished using a Cessna 182 fixed-wing aircraft or a Bell 206 helicopter. On fixed-wing flights the pilot was generally the only observer, whereas helicopter surveys were conducted in conjunction with other PWFWCP wildlife work and thus up to 4 observers (including the pilot) were present.

On each flight an attempt was made to locate all 10 radio-collared females. Observers recorded the location (i.e., latitude and longitude obtained from an on-board GPS unit), group size, and habitat information for each sighting. Habitat data included dominant tree species, slope, and aspect.

Latitude and longitude coordinates were converted to UTM coordinates and plotted on topographic and forest cover maps (Ministry of Forests 1990) to discern site elevations and forest cover designations; additional field notes made in-flight aided in classifying each location into the appropriate forest cover polygon.

Multi-annual home range sizes were calculated for each individual collared female with >10 locations using the 100% minimum convex polygon (MCP) method in Ranges V (Kenward and Hodder 1996). Although not statistically valid due to the low number of radio-locations, the ranges provide an indication of the area used by collared elk over the 2-year post transplant period.

Radio-locations were placed into one of five broad habitat types defined by primary tree species and age classes for analyses:

Conifer	Stands with >80% conifer trees >100 years old.
Mixedwood	Stands with >20% each of conifer and deciduous trees >80 years old.
Deciduous	Stands with >80% deciduous trees >60 years old.
Shrub-grass	Stands of non-productive 80-100 year old aspen, non-productive brush, meadows.
Immature	Includes immature stands of pine, aspen, spruce, and/or birch which have been logged or burned, and not satisfactorily restocked (NSR) lands. Stands are <50 years old.

Calf recruitment was determined by observing the presence or absence of calves with marked cows during the radio-tracking flights.

Radio-collared female elk mortalities were investigated on an opportunistic basis when in the area with a helicopter. Radio-collars were retrieved when possible, and evidence at the site was documented to help ascertain cause of death. Mortality locations were included in habitat use and home range analyses.

3.2 Elk population inventory

A total-count population inventory to assess the status of transplanted elk was conducted on February 9, 2000. The survey was undertaken by BC Environment, in conjunction with a moose survey in the same area. The survey was conducted from a Bell 206 helicopter with a pilot and 3 observers.

The area was surveyed by flying parallel transects 400-500 m apart, at an altitude of 100-400 ft above ground. Observers recorded UTM coordinates (obtained from an on-board GPS unit), group size and composition, and habitat information for each elk sighting. Habitat data included dominant tree species, percent vegetative cover, slope, aspect, and snow depth.

Radio-telemetry equipment was used to lead observers to some collared elk during the survey, therefore they could not be included in the population estimate calculations. The proportion of radio-collared elk observed (unaided by telemetry) during the survey was used as a sightability correction factor to estimate population size. The population estimate was calculated using the modified Lincoln-Petersen mark-recapture estimator (White and Garrot 1990, eqn 10.1, pg 256).

$$N = \frac{(C+1)(M+1)}{(R+1)} - 1$$

where N = population estimate for Ingenika elk
C = total number of elk observed in the survey area
M = total number of radio-collared elk in the population
R = total number of radio-collared elk observed in the survey area

The variance [*Var(N)*] and 95% confidence interval of the population estimate were calculated using:

$$SD^2 = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}$$

$$Var(N) = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}$$

$$95\% \text{ confidence interval} = N \pm 1.96\sqrt{Var(N)}$$

4.0 RESULTS and DISCUSSION

4.1 Monitoring of radio-collared elk

Twelve radio-telemetry flights were conducted between February 1996 and March 1998 (Table 2, Appendix A). Two survey flights conducted in the 2 weeks immediately following the transplant (28 Feb and 7 Mar 1996) confirmed that all 10 radio-collared elk were alive. Four flights were conducted in 1996/97, in every season but calving, while the 6 flights conducted in 1997/98 included 2 winter locations. Of the 10 radio-collared females, 6 were consistently located throughout the 2 year monitoring period (4 with 12 locations and 2 with 11 locations). One elk (951) was located only 4 times before it went missing from the study area or its collar ceased functioning. Three elk (832, 861, 941), located only 6, 5, and 2 times respectively, died within the first year after the transplant (1996/97).

Table 2. Ingenika elk transplant radio-telemetry flight dates, seasons, and survey methods.

	Flight Date	Season[a]	Method
Post-transplant	28 Feb 96	W	fixed-wing
	7 Mar 96	W	fixed-wing
1996/97	25 Apr 96	Sp	fixed-wing
	6 Jul 96	Su	fixed-wing
	4 Oct 96	F	fixed-wing
	12 Mar 97	W	helicopter
1997/98	6 May 97	Sp	helicopter
	6 June 97	C	helicopter
	11 Aug 97	S	helicopter
	16 Oct 97	F	fixed-wing
	10 Jan 98	W	fixed-wing
	21 Mar 98	W	fixed-wing

[a] Winter (1 Nov - 1 Apr); Spring (1 Apr - 15 May); Calving (15 May - 15 Jun); Summer (15 Jun - 1 Sep); Fall rut (1 Sep - 31 Oct).

The highest total numbers of elk sighted during telemetry flights were obtained during the late winter surveys: 20 elk on 12 March 1997, and 31-33 elk on 10 January 1998. Observed group sizes ranged from 1 to 16 animals in the Ingenika Sidehill, Delkluz Flats, and Ingenika Cone areas combined, and 1 to 6 animals in the Frank Creek area (Appendix A). Bulls were visually confirmed to be with collared females in the Ingenika Sidehill, Delkluz Flats, and Ingenika Cone areas on 3 occasions in the fall and winter periods, in addition to an incidental observation of 2 bulls with a group of marked females on Grassy Bluff in late October 1996 (Appendices A and B). No bulls were observed with collared females in the Frank Creek area, however bull elk Orange 30 was incidentally observed near the Factor Ross Creek road. It was difficult to verify ear tags from aircraft so it is unknown whether bulls observed with marked females were resident or transplanted animals. On many occasions females wearing neck bands were seen with collared females, often in groups that did not include resident elk.

4.1.1 Movements and range use

On the first three flights after the release of elk (28 Feb, 7 Mar, and 25 Apr 1996), all but 2 radio-collared females were located in the Delkluz Flats and Ingenika Sidehill areas (Table 3). Elk #941 was located north-west of Ingenika Cone, on the east bank of the Swannell River, on 7 March; a mortality signal for this female was recorded in the same general location on 25 April. Elk #951 was located along the Ingenika River, 8.5 km west of Ingenika Crag, on 25 April.

By 6 July 1996, the elk had begun to disperse. Only one elk (#851) remained on the Ingenika Sidehill, while the others moved to the Delkluz Flats (#812, #872), Ingenika Cone (#823, #832, #861), and Frank Creek (#801) areas. Elk #951 was located along the Finlay River, approximately 30 km northeast of the transplant release site, and was never located again. It is suspected that she left the study area and continued travelling north towards the Kechika River. The radio signal for #842 was not heard, but was located at Frank Creek during the next survey flight.

On subsequent monitoring flights throughout the two year period, collared females #801 and #842 were located exclusively on the easterly slopes adjacent to the Williston Reservoir, between Frank Creek and the Ingenika Arm. The remaining collared females moved between the Ingenika Sidehill, Delkluz Flats, and Ingenika Cone areas. None of the marked elk observed in the Ingenika Sidehill - Delkluz Flats - Ingenika Cone area were observed in the Frank Creek area (and vice versa) once initial dispersal from the transplant release site had occurred.

MCP home range sizes for the 6 radio-collared female elk located consistently throughout the two year monitoring period ranged from 47 to 164 km^2 (Table 4, Figure 3). To account for initial dispersal from the release site, 2 home ranges were calculated for #801 and #842, the first including all post-transplant locations and the second excluding the 3 locations obtained prior to their dispersal to the Frank Creek area (Table 4, Figure 4). This reduces the breadth of established home range sizes for the 6 elk from 13 to 95 km^2, with a mean of 48 km^2 (Table 4).

Table 3. Geographic areas used by radio-collared female elk transplanted to the lower Ingenika River valley in February 1996. Locations were obtained during 12 seasonal monitoring flights between February 1996 and March 1998.

	Flight Date	# of collared female elk[a]	Ingenika Sidehill	Delkluz Flats	Ingenika Cone	Frank Creek	Other	No Location[b]
Post-transplant	28 Feb 96	10	6	4				
	7 Mar 96	10	5	4	1			
1996/97	25 Apr 96	10	8		1		1[c]	
	6 Jul 96	9	1	2	3	1	1[d]	1
	4 Oct 96	9	2	2	2	2		1
	12 Mar 97	9	4	1	1	2		1
1997/98	6 May 97	7	2	1	1	2		1
	6 Jun 97	7	3		1	2		1
	11 Aug 97	7			3	2		2
	16 Oct 97	7	2		2	2		1
	10 Jan 98	7			4	2		1
	21 Mar 98	7			4	2		1

[a] Three radio-collared females died during the Feb 96 – Mar 98 monitoring period.

[b] Radio signal not heard during the monitoring flight.

[c] Elk #951 was located along the Ingenika River, 8.5 km west of Ingenika Crag.

[d] Elk #951 was located along the Finlay River, approximately 30 km northeast of the transplant release site.

Table 4. Two year minimum convex polygon (MCP) home range sizes for 6 radio-collared female elk transplanted to the lower Ingenika River valley in February 1996. Locations (n) were obtained during 12 seasonal monitoring flights between February 1996 and March 1998.

Elk #	n	MCP home range (km^2)
801[a] A	12	164
B	9	13
812	12	95
823	11	53
842[b] A	11	125
B	9	13
851	12	47
872	12	66

[a] Two home range sizes (A and B) were calculated for elk #801 and #842; B was calculated without the first 3 locations to reflect the subsequent dispersal of these females from the transplant release site to the Frank Creek area.

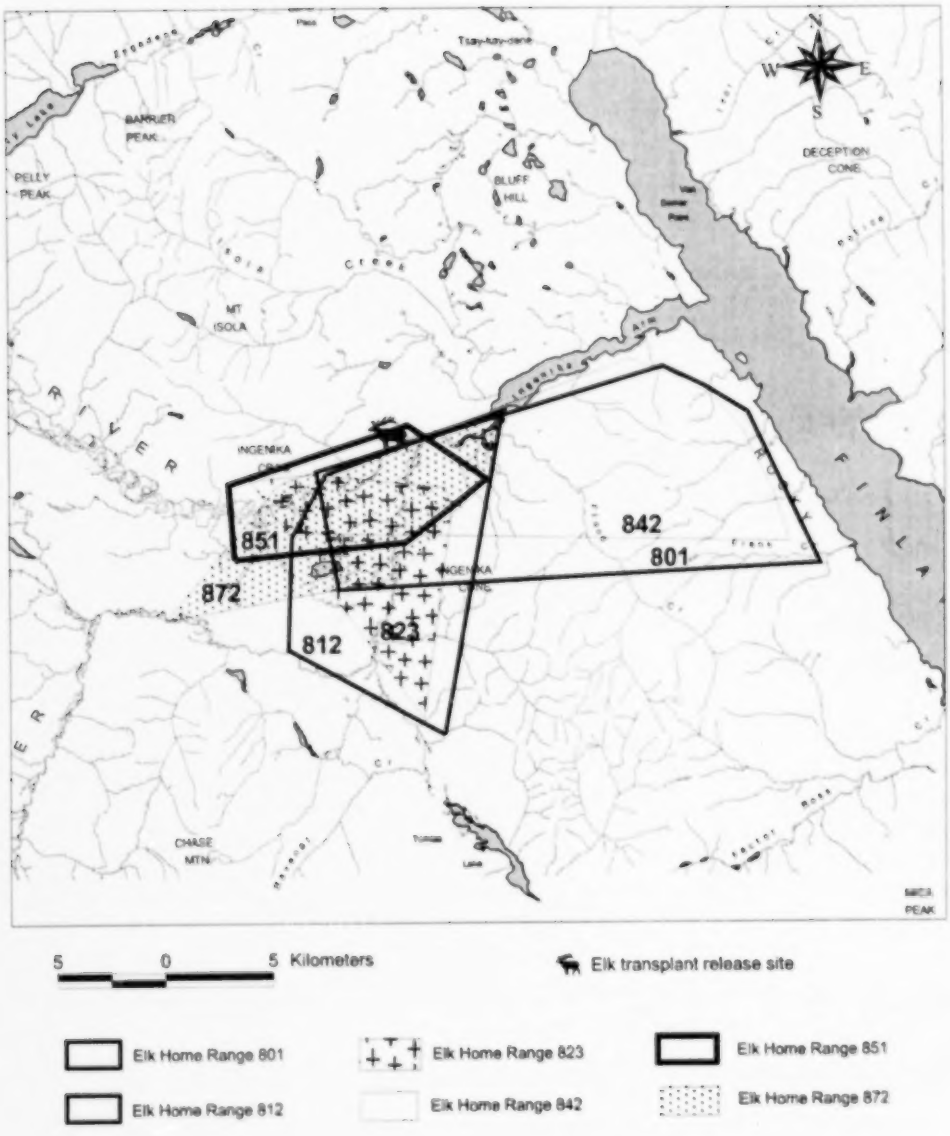

Figure 3. Two year minimum convex polygon home ranges for 6 radio-collared female elk transplanted to the lower Ingenika River valley in February 1996. Locations were obtained during 12 seasonal monitoring flights between February 1996 and March 1998.

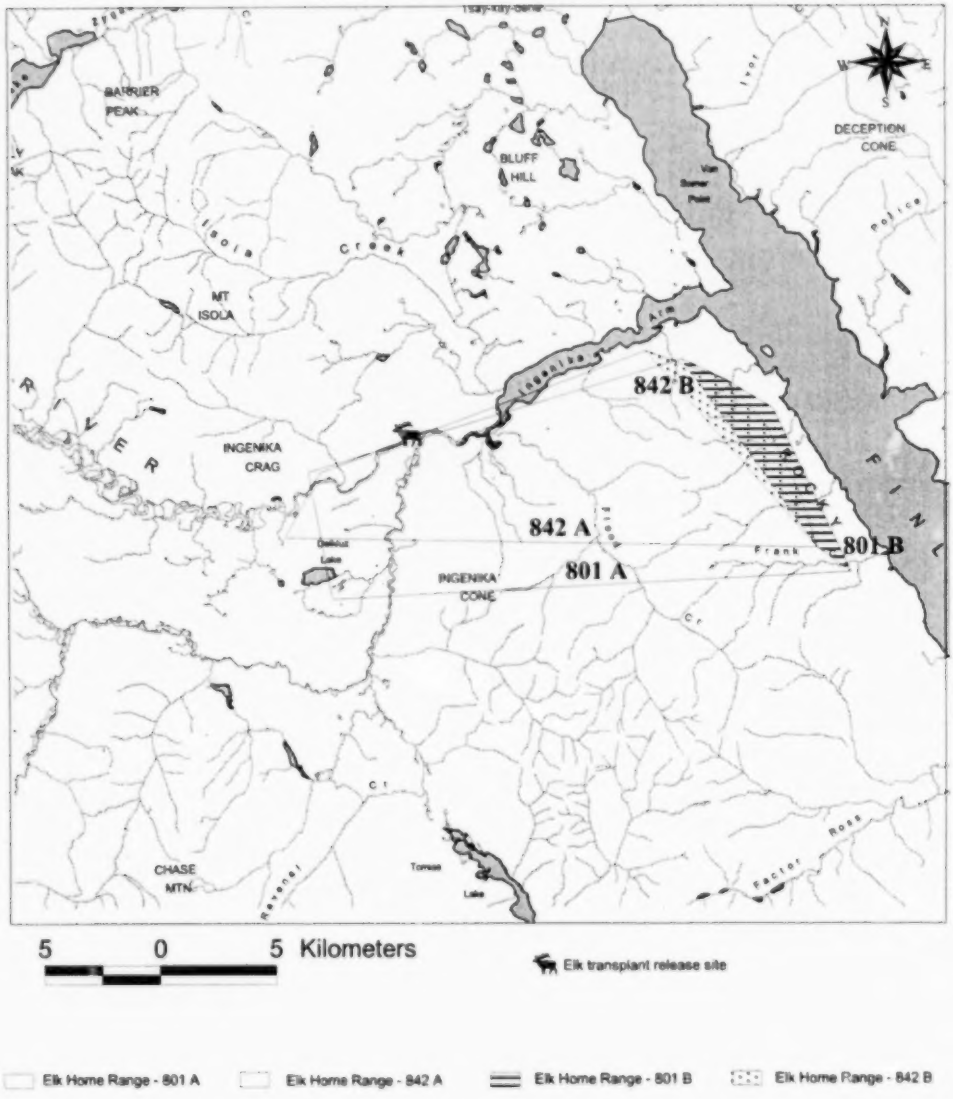

Figure 4. Two year minimum convex polygon home ranges for elk #801 and #842, translocated to the lower Ingenika River valley in February 1996. Ranges 801 A and 842 A include all 12 locations obtained during the seasonal monitoring flights (Feb 96 - Mar 98). Ranges 801 B and 842 B exclude the first 3 locations (Feb 96 - Apr 96) obtained prior to the establishment of home ranges in the Frank Creek area.

Most elk in northern BC are non-migratory, summering and wintering on the same or adjacent ranges (Demarchi et al. 1992). Both the Ingenika group and the Frank Creek group showed no distinct use of separate seasonal areas. Five cow elk from the Dunlevy transplant herd along the Peace Arm of the Williston Reservoir were radio-collared and monitored for 3 years (1991-1994); they also appeared to be non-migratory with no distinct separation of seasonal ranges (Backmeyer 2000). Home range sizes for the 5 Dunlevy females ranged from 23.3 to 41.5 km^2, with a mean of 31.2 km^2 (Backmeyer 2000). The calculated established home ranges for radio-collared females in this study were larger on average (13 – 95 km^2, mean 48 km^2). Larger home range sizes may be an indication of poorer habitat quality or increased competition for resources.

Dispersal to range areas disjunct from other individuals in the population is suggestive of a colonizing event. Colonist elk may escape intraspecific competition on traditional range via temporary migration or establishment of new home ranges (Skubinna and Van Dyke 1991). Elk #951, #801 and #842 may be acting as colonists; #951 migrated far out of the Ingenika drainage, while #801 and #842 dispersed to colonize the Frank Creek area adjacent to the Williston Reservoir. The "colonists" (#801 and #842) in the Frank Creek area established smaller home ranges than other radio-collared elk in the Ingenika herd. Elk movement may be limited by the Williston Reservoir to the north and east, and the Butler Range to the west, but the smaller range sizes may also reflect fewer numbers of elk in the area, and thus less competition for resources, or higher quality habitat.

4.1.2 Habitat use

Radio-collared female elk were located primarily in shrub-grass and/or immature habitats in all seasons except calving, when 2 of the 6 collared females were in immature habitats and the remaining used mixedwood forest (Table 5). Shrub-grass habitats were utilized in winter and spring only, while immature habitats were utilized in all seasons. Radio-collared elk were also present in coniferous, mixedwood, and deciduous forest habitats throughout the year (Table 5). Detailed habitat use information for individual radio-collared elk is provided in Appendix A.

Table 5. Habitat utilization by radio-collared female elk translocated to the lower Ingenika River valley in February 1996. Locations (n) were obtained during 12 seasonal monitoring flights, from February 1996 through March 1998.

Season	Date	n	Habitat types[a]					Mean elevation (m)
			Conif	Mixed	Decid	SG	Imm	
WINTER	28 Feb 1996	10	1			5	4	831
	7 Mar 1996	10	1			7[b]	2	851
	12 Mar 1997	8	2	3		3		788
	10 Jan 1998	6	2				4	839
	21 Mar 1998	6	1	4			1	773
	Total (%)		**7 (18)**	**7 (18)**	**0**	**15 (37)**	**11 (27)**	
SPRING	25 Apr 1996	10			3	5	2	780
	6 May 1997	6		1		2	3	806
	Total (%)		**0**	**1 (6)**	**3 (19)**	**7 (44)**	**5 (31)**	
CALVING	6 Jun 1997	6		4			2	800
	Total (%)			**4 (60)**			**2 (40)**	
SUMMER	6 July 1996	8	2	3			3	928
	11 Aug 1997	5	1				4	833
	Total (%)		**3 (20)**	**3 (20)**	**0**	**0**	**9 (60)**	
RUT	4 Oct 1996	8	1	3	2		2	853
	16 Oct 1997	6		2			4	892
	Total (%)		**1 (7)**	**5 (36)**	**2 (14)**	**0**	**6 (43)**	

[a] Conif = conifer, Mixed = mixedwood, Decid = deciduous, SG = shrub-grass, Imm = immature

[b] One location may have been in mature conifer (i.e., elk 951 was not seen, but appeared to be at the edge of shrub-grass and conifer habitats).

The Ingenika River valley's relatively low snow accumulations and mosaic of seral habitats are favourable for elk. The 6 radio-collared female elk located throughout the 2 year monitoring period exhibited habitat use patterns similar to those of 5 collared females from the Dunlevy herd: collared females showed significant preference for shrub-grass habitat in early and late winter, and for deciduous habitat during the calving season (Backmeyer 2000). In an elk study in the Tuchodi River area of northeast BC, elk selected a wide variety of vegetation types and successional stages throughout the year; 3-7 year old upland shrub-grass types were used extensively in all seasons and were preferred winter forage habitats (Peck and Currie 1992). The majority of elk summer use was within the shrub-grass types but a variety of successional and mature vegetation types were also used (Peck and Currie 1992).

Shrub and grassland habitats on south- and west-facing river escarpments have been identified as the most critical habitats for elk in northern BC (Demarchi et al. 1992). Shrub-grass habitats are seral and maintained by fire; in the absence of burns they quickly revert to aspen and conifers. Not surprisingly, major elk winter ranges have been associated with burns (Peck and Currie 1992). Since winter range availability is thought to limit the distribution and abundance of most northern ungulates (Peck and Currie 1992), prescribed burns have become a common enhancement tool to boost ungulate populations. Successful burns have resulted in marked increases in elk numbers in portions of northcentral and northeastern BC, including the Muskwa Foothills and the Kechika River drainage (Demarchi et al. 1992, Peck and Currie 1992). A series of spring burns have been conducted along the Peace Reach since the early 1980s to benefit elk in the Dunlevy transplant area (Wood 1996a,b; Corbould 1999; PWFWCP, data on file), and in the Pelly Creek (Wood 1996c), Akie River (PWFWCP, data on file), and Pesika Creek (Wood 1998b) drainages to benefit small populations of elk residing in those areas. The PWFWCP plans to conduct a prescribed burn near Ingenika Crag to enhance early seral habitat for the transplanted elk.

4.1.3 Recruitment

Radio-collared female elk were not monitored during the calving period in 1996 (Year 1), however, by early October, 5 of 8 collared females in the study area were confirmed to be without calves. Only one female (#801) was seen with a calf by mid-March; 6 had no calves, and 1 was unconfirmed.

The 6 collared adult females alive in the spring of 1997 (Year 2) were monitored once during the calving period (June 6); one newborn was sighted with #872, however calves could not be verified with the remaining 5 females. By October, 1 female had a calf, 1 did not, and 4 remained unconfirmed. Three neck-banded females were also sighted with calves in August of 1997: Orange #20, Orange #21, and Yellow #2. No cow/calf data was available for late winter (March).

Although sightings of calves with individual collared females were few, calves were sighted with groups of marked animals (radio collars and/or neck bands) in both years. The proportion of calves in the groups ranged from 17% to 30% (for sightings between October and January of both years).

Elk populations are strongly affected by variations in calf survival (Taber et al. 1982). Although calf production and survival data could not be obtained for most of the collared females, Year 1 data shows 13-25% calf survival in winter. The number of calves sighted with groups of marked females (17 – 30% of group) suggest a low amount of recruitment. A winter (Jan/Feb) cow/calf ratio of 30-40 calves per 100 cows has been suggested as a reasonable level of recruitment for elk populations (Larry Ingham, Columbia Basin Fish and Wildlife Compensation Program, Invermere, personal communication).

4.1.4 Mortality

Mortality signals were received for 3 radio-collared elk over the 2-year study period: #941 on 25 April 1996, and both #832 and #861 on 12 March 1997. Elk #941's collar was retrieved on 29 April 1996 from a mixedwood stand at 810 m, northwest of Ingenika Cone and 1.5 km east of the Swannell River. The complete jaw bone and vertebrae, and the top half of the skull were present, as well as scattered hair and other bones. The remains were scavenged (wolves chewed extensively on the collar), but the cause of death was unknown.

The radio collar for #832 was retrieved on 6 May 1997 from the edge of a lodgepole pine/black spruce meadow (855 m) approximately 4 km south of Delkluz Lake. There were tooth marks on the battery and antenna, and the collar's webbing had been chewed. The presence of wolf scat containing bone and hair, and the scattered remains of elk hair, bones, and pieces of the collar were suggestive of a wolf kill.

Elk #861's radio-collar was also retrieved on 6 May 1997 from an open grassy area of the steep south-facing slope just east of Ingenika Crag (elevation 770 m). A few vertebrae and the lower jaw bone were located in a swathe of hair scattered down-slope into the aspen. The collar itself was cleanly broken (possibly cut) with only one tooth mark present on the battery. There was slight damage to the antenna, but no tooth damage to the collar itself. This site is in close proximity to a road; poaching may be a plausible cause of death.

Incidental reports of elk mortality in the Ingenika elk transplant area and surroundings were also received: elk #851's collar was heard on mortality, in February 1999, in a gully east of Ingenika Arm, 2 died of natural causes and one elk was shot (2 of the latter 3 were confirmed to be marked from the transplant; Table 6).

Table 6. Incidental reports of elk mortality in the lower Ingenika River drainage and surrounding areas.

Report Date	Location	n	Observation and comments	Source
Spring 96	Along the Ingenika R. below Grassy Bluffs	1	Male calf w/ ear tag (#78); possible wolf kill	Rob Johnson
Sp/Su 96	Adjacent to the Finlay R., south of Ft. Ware	1	Dead in a log jam	Steve Dowling[a]
Sp/Su 96	No data	1	Female with yellow neck band (#14) shot	Steve Dowling[a]
Feb 99	In gully east of Ingenika Arm	1	Mortality signal for radio-collar 851; cause of death unknown	Line Giguere

[a] Second-hand report

Sixty-seven percent of the 9 radio-collared adult female elk that were monitored throughout the 2 year monitoring period survived. This is lower than the mean annual survival rate of 0.77 in a study of 35 translocated adult female elk in Oregon (Stussy et al. 1994), however, the precision of survival estimates is poor with ≤20 animals in the study group (Pollock et al. 1989 as cited in Stussy et al). The principal causes of mortality in yearling and older elk include predation, hunting, environmental stresses, and accidental death (Taber et al. 1982). Wolves are thought to be the primary predators for elk in the Ingenika area. Hunter harvest of elk has been regulated, and at times restricted, in the Omineca Region since the 1960s (Ritchie 1992). There is currently no open hunting season for elk in the Ingenika River area (Management Units 7-38, 7-39, and 7-40), however access to this area subjects these elk to both sustenance hunting by local native bands and poaching.

4.2 Elk population inventory

Weather conditions during the 9 February 2000 survey were mild: winds were calm at 5-10 knots, the sky was 100% overcast, and air temperature was -14°C. Snow depth was estimated at between 15 and 50 cm throughout the survey area; the last significant snowfall was on 8 February, 2000. Snow depths were low throughout the Williston watershed and February was very dry with relatively warmer than usual conditions (2°C above the monthly mean; BC Environment 2000).

Thirteen (13) elk, including 2 radio-collared females (#812 and #823), were observed in 4 groups during the survey (Table 7, Figure 5). The radio-collar on elk #812 was not functional, presumably due to a dead battery. Only one elk with a nylon neckband was observed during the survey (25 elk had neckbands in 1996). Radio-tracking during the survey confirmed that 3 other radio-collared elk were alive and present in the study area.

These elk were located in 2 groups, both in dense cover, with 18 other elk (Table 7, Figure 5). Thus, at the time of the survey, 4 elk had functional radio-collars and were present in the survey area; only 1 of these was sighted (unaided by telemetry) during the survey.

Table 7. Locations and classifications of all Rocky Mountain elk groups located during the Ingenika elk population inventory on 9 February, 2000.

		Age and Sex Classification[a]							Total	
Group	General Location	YM	I	II	III	IV	F	C	Number	Collared elk
1	Ingenika Sidehill					1			1	
2	N of Ingenika Arm				1				1	
3	N of Ingenika Arm				1				1	
4	Frank Creek			1			7	2	10	823, 812, Orange 25
5[b]	S of Ingenika Arm						3	2	5	842
6[b]	S of Ingenika Arm		1	1			11	3	16	802, 872
		0	1	2	2	1	21	7	34	

[a] Age and sex classification: YM (Yearling Male), I (Class I male), II (Class II male), III (Class III male), IV (Class IV male), F (Female), C (Calf).

[b] Observers were led to elk groups with radio-telemetry equipment during the survey.

The Ingenika elk population is estimated at 34 animals based on the proportion of collared animals observed unaided by telemetry. Applying 95% confidence limits places the estimated population size between 6 - 62 animals. Given that a total of 34 elk were observed during the survey, an adjusted estimate for the population size is between 34 and 62 animals.

Perhaps one of the best measures of a transplant's long-term success is the population's rate of growth and/or overall stability. Intrinsic factors that influence population growth rates include age composition, sex ratios, recruitment, and animal mortality. Estimates of growth rates of recently reintroduced and unhunted populations of elk 6 to 8 years after introduction vary from 0.18 to 0.37 (Gogan and Barrett 1987). A review of ungulate introductions to previously unoccupied areas revealed a pattern of increase to high density and subsequent crash to lower level (Caughley 1970, as cited in Gogan and Barrett 1987). Unless density independent factors (e.g., disease, inadequate habitat, severe winters) prevent population expansion, successful transplants to augment small existing populations might be expected to follow the same pattern (Gogan and Barrett 1987).

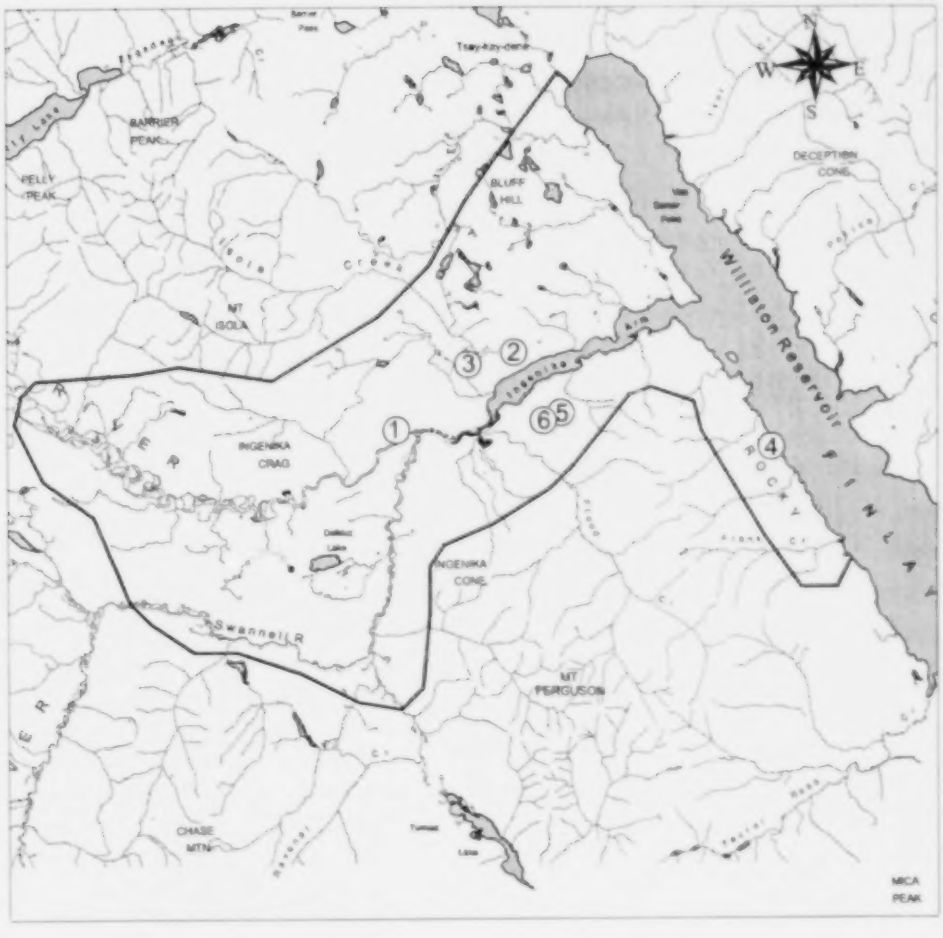

Figure 5. Survey area boundary and elk group locations obtained during the total-count population inventory in the lower Ingenika River valley on 9 February, 2000.

The calculated population estimate of 34 to 62 animals indicates that the Ingenika elk herd has not grown as a result of the transplant. It is possible that factors such as elk mortality, emigration, and habitat suitability may be limiting population growth in the lower Ingenika River area, resulting in a lower than anticipated population estimate. Radio-collared female elk mortality during this study was moderately high (4 of 9 elk monitored throughout the study period died within 4 years of the transplant). The average annual female mortality was 12.5%, slightly above the annual adult female mortality rate of 10% used to calculate the projected post-transplant population level of 65 animals after 4 years (Wood 1998a). Mortalities appeared to result primarily from natural causes, particularly wolf predation. Reported human-induced mortalities are few, as there is no open season for elk hunting in the study area. Calf recruitment (17-30%) and survival (13-25% in Year 1) appeared to be low; the projected post-transplant population size calculations assumed an annual calf survival rate of 25% (Wood 1998a). The Ingenika elk population was not likely affected by adverse weather conditions in recent years. With the exception of winter 1995/96, snowpacks in the Williston watershed have been at or below normal levels in the years since the transplant (1996-2000; BC Environment 2000).

Of the 10 elk radio-collared in 1996 two established home ranges separate from the others and one left the study area altogether, indicating that dispersal and emigration from the Ingenika elk herd occurred during the monitoring period. Elk dispersal and emigration may represent an effort to find improved ranges with less competition for resources. If the population is limited by forage resources, then herd size might be expected to respond favourably to the PWFWCP's prescribed burn near Ingenika Crag. Burning will increase the proportion of open, early-seral forage habitats in the lower Ingenika River area.

5.0 CONCLUSIONS

Elk fidelity to the release site, as well as habitat suitability and animal mortality, are factors to consider when gauging the short-term success of a transplant (Sullivan et al. 1991). Of the 10 radio-collared elk translocated to the Ingenika release site, 4 expressed fidelity to range in the vicinity of the release site (Ingenika Sidehill, Delkluz Flats, and Ingenika Cone areas), 2 established home ranges nearly 20 km away on the east-facing slopes adjacent to the Williston Reservoir (Frank Creek area), one emigrated from the lower Ingenika River area, and 3 died during the intensive 2-year monitoring period (February 1996 - March 1998).

Perhaps the best measure of a transplant's long-term success is the population's overall growth and/or stability. The results of the total-count elk inventory conducted in February 2000 do not indicate that the elk population is growing as a result of the February 1996 transplant. The expected population size of approximately 65 animals in 4 years (based on the actual age/sex ratio of the transplanted animals) was not met (Wood 1998a). The previous estimate of 30-50 animals (Demarchi et al. 1992, Ritchie 1992, Spalding 1992) appears to remain valid as a conservative, minimum estimate.

The occurrence of slightly higher adult and calf mortality than predicted, and colonizing and emigration events, suggests that the population may be limited by predation, habitat quality, and/or resource competition. Immature and shrub-grass habitats were used predominantly by elk throughout much of the year. Enhancement of these habitat types may relieve competition for forage resources. Completion of the prescribed burn planned by the PWFWCP for an area near the Ingenika Crag is expected to benefit resident elk by providing increased early seral forage areas. A population inventory should be conducted subsequent to the burn to re-assess the Ingenika elk herd's status.

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The population inventory was conducted by Doug Heard (BC Environment, Prince George), Glen Watts (BC Environment, Prince George), and Mike Demarchi (LGL Limited, Sidney), using two separate helicopters. Pamela Hengeveld (PWFWCP, Prince George), Steve Johnson (LGL Limited, Sidney), and Robert Tomah (Pacific Slope, Mackenzie) served as observers and data recorders. Pierre Bock and Nick Konecny (Canadian Helicopters, Prince George) piloted the survey flights.

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Appendix A. Detailed habitat use data for radio-collared elk transplanted to the Ingenika River area in February 1996 and monitored seasonally from February 1996

Date	Elk[a]	Loc'n[b]	East	North	Elv (m)	Slp (%)[c]	Asp[c]	BGZ[d]	Forest Cover	Hab[e]	B / L[f]	Group size and composition[g]	
28/02/1996	801	DF	367572	6282545	820	0	0	BWBS	PlSb 823 P4	C		2	1 Yn
28/02/1996	812	DF	365636	6285280	790	0	0	BWBS	PlA 110 P1	Imm	B70	4	with 823, 842, 1nn
28/02/1996	823	DF	365636	6285280	790	0	0	BWBS	PlA 110 P1	Imm	B70	4	with 812, 842, 1nn
28/02/1996	832	IS	364983	6287529	800	15	180	BWBS	NPA 512-2	SG		7	with 851, 861, 872, 1 On, 1 eartag
28/02/1996	842	DF	365636	6285280	790	0	0	BWBS	PlA 110 P1	Imm	B70	4	with 812, 823, 1 nn
28/02/1996	851	IS	364983	6287529	800	15	180	BWBS	NPA 512-2	SG		7	with 832, 861, 872, 1 On, 1 eartag
28/02/1996	861	IS	364983	6287529	800	15	180	BWBS	NPA 512-2	SG		7	with 832, 851, 872, 1 On, 1 eartag
28/02/1996	872	IS	364983	6287529	800	15	180	BWBS	NPA 512-2	SG		7	with 832, 851, 861, 1 On, 1 eartag
28/02/1996	941	IS	368345	6289260	990	5	225	BWBS	NSR -/M	Imm	B84	1	7-10 moose within 200 m
28/02/1996	951	IS	365310	6287871	930	15	180	BWBS	NPA 512-2	SG		n/s	3 moose, and cow/calf moose nearby
28/02/1996	xx	IS	366372	6287650								6	nn or collars, 1 5pt bull
28/02/1996	xx	IS										1	Yn
28/02/1996	xx	IS										2	5pt bulls
28/02/1996	xx	X										1	unclassified
28/02/1996	xx	X										2	bulls
28/02/1996	xx	X										1	bull
07/03/1996	801	DF	367209	6285267	850	0	0	BWBS	Sp meadow	SG		>3	with 842
07/03/1996	812	DF	365504	6285006	790	30	180	BWBS	PlA 110 P1	Imm	B70	2	with 823
07/03/1996	823	DF	365504	6285006	790	30	180	BWBS	PlA 110 P1	Imm	B70	2	with 812
07/03/1996	832	IS	365507	6287939	940	10	180	BWBS	NPA 512-2	SG		3	1 On
07/03/1996	842	DF	367209	6285267	850	0	0	BWBS	Sp meadow	SG		>3	with 801
07/03/1996	851	IS	365696	6287785	840	0	0	BWBS	NPA 512-2	SG		4 or 5	with 861, 872
07/03/1996	861	IS	365696	6287785	840	0	0	BWBS	NPA 512-2	SG		4 or 5	with 851, 872
07/03/1996	872	IS	365696	6287785	840	0	0	BWBS	NPA 512-2	SG		4 or 5	with 851, 861
07/03/1996	941	IC	370314	6284929	740	0	0	BWBS	S 741 G5	C		1	

[a] Elk: xx denotes non-radio collared elk.

[b] Locations of radio-collared elk: Ingenika Sidehill (IS), Delkluz Flats (DF), Ingenika Cone (IC), Frank Creek (FC). X = no location (radio signal not heard).

[c] Slope & aspect: values 99 and 999 denote 'no data'.

[d] BGZ: biogeoclimatic zones. Boreal White and Black Spruce (BWBS), Spruce-Willow-Birch (SWB).

[e] Habitat: Conifer (C), Mixedwood (M), Deciduous (D), Shrub-grass (SG), Immature (Imm).

[f] B / L: B58 = burned in 1958, L = logged, P = planted, S = spaced.

[g] Group size: n/s = not seen. Group composition: Orange neckband (On), Yellow neckband (Yn), no neckband (nn).

Appendix A. Continued.

Date	Elk[a]	Loc'n[b]	East	North	Elv (m)	Slp (%)[c]	Asp[c]	BGZ[d]	Forest Cover	Hab[e]	B / L[f]	Group size and composition[g]	
07/03/1996	951	IS	364222	6287999	1030	10	180	SWB	NPA512-2/ BS(Pl)832P4	SG/C			
07/03/1996	xx	IS										5	1 Yn, possibly 1 with eartag
07/03/1996	xx	IS										1	
25/04/1996	801	IS	366786	6288047	810	10-15	180	BWBS	NPA 512-2	SG		2	with 872
25/04/1996	812	IS	367220	6287885	750	5	180	BWBS	A 522 P4	D		2	1 On
25/04/1996	823	IS	366681	6287957	795	10-15	180	BWBS	NPA 512-2	SG		8	with 832, 861, 3 On
25/04/1996	832	IS	366681	6287957	795	10-15	180	BWBS	NPA 512-2	SG		8	with 823, 861, 3 On
25/04/1996	842	IS	367285	6288012	760	5-10	180	BWBS	A 522 P4	D		2	with 851
25/04/1996	851	IS	367285	6288012	760	5-10	180	BWBS	A 522 P4	D		2	with 842
25/04/1996	861	IS	366681	6287957	795	10-15	180	BWBS	NPA 512-2	SG		8	with 823, 832, 3 On
25/04/1996	872	IS	366786	6288047	810	10-15	180	BWBS	NPA 512-2	SG		2	with 801
25/04/1996	941	IC	371801	6284790	810	99	999	BWBS	PIA 220 M1	Imm	B58	DEAD	
25/04/1996	951	other	356362	6290118	710	25-30	180	BWBS	PIA 110 P1	Imm	B70	4	2 On, 1 nn
25/04/1996	xx	IS										1	
06/07/1996	801	FC	387777	6285613	950	10	90	BWBS	PIS 831 M4	C		2	1 Yn
06/07/1996	812	DF	365104	6279857	810	5	180	BWBS	PIA 733 M3	M		n/s	
06/07/1996	823	IC	371342	6277137	1065	30	90	BWBS	PIS(B) 733 M4	C		n/s	
06/07/1996	832	IC	371137	6278796	1080	25	315	BWBS	PI 210 P1	Imm	B58	1	
06/07/1996	842	X											
06/07/1996	851	IS	368504	6288457	745	40	180	BWBS	NSR -/P	Imm	B84	1	
06/07/1996	861	IC	371800	6281430	1200	20	270	SWB	PI 210 P1	Imm	B58	1	
06/07/1996	872	DF	359450	6281500	900	0	0	BWBS	SA(Pl) 741 G5	M		n/s	
06/07/1996	951	other	376100	6315200	675	0	0	BWBS	ASPl 731 M5	M		n/s	
04/10/1996	801	FC	383110	6292182	910	99	360	BWBS	PIS 731 G3	C		n/s	
04/10/1996	812	IC	372180	6275590	980	99	270	BWBS	API 531 M5	M		n/s	
04/10/1996	823	IS	365870	6286500	680	0	0	BWBS	SA 640 G4	M		>8	with 872
04/10/1996	832	IC	371224	6281299	1050	99	270	BWBS	PI 210 P1	Imm	B58	n/s	
04/10/1996	842	FC	387947	6286221	930	99	90	BWBS	SBi(Pl) 110 M1	Imm	L78S 79	1	
04/10/1996	851	DF	362793	6284160	805	0-5	360	BWBS	A(Pl) 531 M5	D		2	1 large bull
04/10/1996	861	DF	367958	6283777	790	0-5	360	BWBS	A 420 P4	D		1	
04/10/1996	872	IS	365870	6286500	680	0	0	BWBS	SA 640 G4	M		>8	with 823
04/10/1996	951	X											

Appendix A. Continued.

Date	Elk[a]	Loc'n[b]	East	North	Elv (m)	Slp (%)[c]	Asp[c]	BGZ[d]	Forest Cover	Hab[e]	B / L[f]	Group size and composition[g]
12/03/1997	801	FC	386095	6289854	940	20	45	BWBS	ASPI(Bi) 631 P3	M		4 with 842, 1 On (#5 or #6), 1calf (9 mos; with collared female)
12/03/1997	812	IS	375577	6290506	670	0	0	BWBS	meadow	SG		9 with 872, 3 On (#25, #30 [3pt bull], and #unknown), 1 Yn (#7), 1 calf (with Yn#7?), 1 6pt bull, 1 5pt bull
12/03/1997	823	IS	366105	6286528	690	99	999	BWBS	SA 640 G4	M		1
12/03/1997	832	DF	367135	6279300	855	99	180	BWBS	PI(S) 823 P4	C		DEAD
12/03/1997	842	FC	386095	6289854	940	20	45	BWBS	ASPI(Bi) 631 P3	M		4 with 801, 1 On (#5 or #6), 1 calf (9 mos; with collared female)
12/03/1997	851	IC	370783	6284580	765	0	0	BWBS	PI(A) 733 M3	C		1
12/03/1997	861	IS	365750	6287580	770	99	999	BWBS	NPA 512-2	SG		DEAD
12/03/1997	872	IS	375577	6290506	670	0	0	BWBS	meadow	SG		9 with 812, 3 On (#25, #30 [3pt bull], and #unknown), 1 Yn (#7), 1 calf (with Yn#7?), 1 6pt bull, 1 5pt bull
12/03/1997	951	X										
12/03/1997	xx	IS	364535	6287246								2 2 Yn (#5 and #8)
12/03/1997	xx	IS	366423	6286889								2 1 On (#20), 1 nn
12/03/1997	xx	IS	364258	6287534								1 Yn (#13)
06/05/1997	801	FC	386963	6289886	740	5-10	90	BWBS	SBi(A) 110 M/P1	Imm	L78P 80	2
06/05/1997	812	DF	370095	6283153	730	0	0	BWBS	PI 210 P1	Imm	B58	1
06/05/1997	823	IS	365314	6287667	820	30	180	BWBS	NPA 512-2	SG		1
06/05/1997	842	FC	386668	6289133	920	5-10	90	BWBS	ASPI(Bi) 631 P3	M		3 1 Yn (#6), 1 nn
06/05/1997	851	IS	362689	6287641	895	30-40	999	BWBS	PIA 110 P1	Imm	B70	2 1 On (#24)
06/05/1997	872	IC	370220	6282932	730	0	0	BWBS	NPBr	SG		6 3 On (#22,#23, #25), 1Yn (#7), 1 calf (11 mos.)
06/05/1997	951	X										
06/06/1997	801	FC	384978	6291205	870	30	135	BWBS	ASPI 831 M3	M		4 with 842, 1 On (#17), 1 yearling
06/06/1997	812	IS	372752	6289532	710	0	0	BWBS	NSR -/M	Imm	B85	1
06/06/1997	823	IS	371227	6276398	840	30	270	BWBS	API 531 M5	M		1
06/06/1997	842	FC	384978	6291205	870	30	135	BWBS	ASPI 831 M3	M		4 with 801, 1 On (#17), 1 yearling
06/06/1997	851	IS	371145	6290000	840	15	180	BWBS	AS(PI) 622 P4	M		3 2 On
06/06/1997	872	IS	374226	6289310	670	99	999	BWBS	NSR -/M	Imm	B85	2 1 newborn calf
06/06/1997	951	X										

Appendix A. Continued.

Date	Elk[a]	Loc'n[b]	East	North	Elv (m)	Slp (%)[c]	Asp[c]	BGZ[d]	Forest Cover	Hab[e]	B / L[f]	Group size and composition[g]	
11/08/1997	801	FC	389590	6283090	875	10	90	BWBS	PIS(Bi) 110 M1	Imm	L77S 79	3	Yn (#2) with a calf were both 100 m away from # 801
11/08/1997	812	IC	374784	6287522	765	99	999	BWBS	PIA 220 M1	Imm	B58	>3	with 872, 1 nn and no eartag (slightly smaller)
11/08/1997	832	X											
11/08/1997	842	FC	387588	6286157	995	20	45	BWBS	PI(S) 823 P3	C		1	
11/08/1997	851	IC	374677	6287358	765	99	999	BWBS	PIA 220 M1	Imm	B58	5	2 On (#20, #21), both with calves
11/08/1997	872	IC	374784	6287522	765	99	999	BWBS	PIA 220 M1	Imm	B58	>3	with 812, 1 nn and no eartag (slightly smaller)
11/08/1997	951	X											
16/10/1997	801	FC	388608	6283828	1050	99	999	BWBS	NSR -/M MS80	Imm	L79	7	3 neckbands and 2 calves
16/10/1997	812	IC	371967	6288554	695	99	999	BWBS	PIA 220 M1	Imm	B58	3	1 calf
16/10/1997	823	IS	363695	6287793	930	99	999	BWBS	PIAS 731 M3	M		6	group of "cows and calves"
16/10/1997	842	FC	388608	6283828	1050	99	999	BWBS	NSR -/M MS80	Imm	L79	7	3 neckbands and 2 calves
16/10/1997	851	IS	363695	6287793	930	99	999	BWBS	PIAS 731 M3	M		6	group of "cows and calves"
16/10/1997	872	IC	371967	6288554	695	99	999	BWBS	PIA 220 M1	Imm	B58	3	1 calf
16/10/1997	951	X											
10/01/1998	801	FC	389999	6282733	880	99	999	BWBS	PI(A) 741 G5	C		4	1 Yn
10/01/1998	812	IC	373006	6286127	775	99	999	BWBS	PIA 220M1	Imm	B58	15	with 823, 851, 872, and includes at least 4 On, 4 Yn or white collars, at least 3 calves, 1 small bull
10/01/1998	823	IC	373006	6286127	775	99	999	BWBS	PIA 220 M1	Imm	B58	15	with 812, 851, 872, and includes at least 4 On, 4 Yn or white collars, at least 3 calves, 1 small bull
10/01/1998	842	FC	387014	6287230	1055	99	999	BWBS	SPI(A) 831 M4	C		n/s	2 sets of tracks in new cutblock
10/01/1998	851	IC	373006	6286127	775	99	999	BWBS	PIA 220 M1	Imm	B58	15	with 812, 823, 872, and includes at least 4 On, 4 Yn or white collars, at least 3 calves, 1 small bull
10/01/1998	872	IC	373006	6286127	775	99	999	BWBS	PIA 220 M1	Imm	B58	15	with 812, 823, 851, and includes at least 4 On, 4 Yn or white collars, at least 3 calves, 1 small bull
10/01/1998	951	X											
10/01/1998	xx	IS	364523	6287525								12	2 Yn, 1 On, 2-3 calves

Appendix A. Continued.

Date	Elk[a]	Loc'n[b]	East	North	Elv (m)	Slp (%)[c]	Asp[c]	BGZ[d]	Forest Cover	Hab[e]	B / L[f]	Group size and composition[g]	
21/03/1998	801	FC	385982	6290172	920	99	999	BWBS	PI 631 M5	C		4	
21/03/1998	812	IC	372707	6287046	745	99	999	BWBS	PIA 633 M3	M		16	with 823, 851, 872, and at least 4 On
21/03/1998	823	IC	372707	6287046	745	99	999	BWBS	PIA 633 M3	M		16	with 812, 851, 872, and at least 4 On
21/03/1998	842	FC	381573	6292615	735	99	999	BWBS	PIA 220 M2	Imm	B58	2	
21/03/1998	851	IC	372707	6287046	745	99	999	BWBS	PIA 633 M3	M		16	with 812, 823, 872, and at least 4 On
21/03/1998	872	IC	372707	6287046	745	99	999	BWBS	PIA 633 M3	M		16	with 812, 823, 851, and at least 4 On
21/03/1998	951	X											

APPENDIX B. Incidental observations of elk in the lower Ingenika River area.

Approx. Sighting Date	Location	n	Observation	Source
January 19 1995	Just west of Ingenika Crag	3	bulls	Fraser Corbould
Spring 1996	Ingenika Cone sidehill	1	orange neckband (#13 or #15?)	Rob Johnson
	Diamond Creek	5	1 yellow neckband and some with eartags	Rob Johnson
	Old Ingenika Village	1	yellow neckband (#28?)	Rob Johnson
Spring-summer 1996	Frank Creek (km 90)	n/d[a]	unclassified group	Steve Dowling[b]
	Factor Ross Creek	1	orange neckband (bull elk; #30)	Dana Becker[b]
October 13 1996	Near Ole Creek (km 60)	2	adult females	Steve Dowling[b]
	Near Ole Creek (km 60)	5	adult females, some with neckbands/collars	Steve Dowling[b]
late October 1996	Ingenika sidehill	9	3 radio collars, 2 yellow neckbands, 1 spike bull, 1 5-6pt bull, 2 calves	Rob Johnson
April 29 1999	Ingenika sidehill	4	1 radio collar, orange neckband (#20) with calf (11 mos.), 1 yearling	Mari Wood
January 20 1999	West of Ingenika Arm	34	unclassified group including 7 juveniles	Line Giguere
May 3 1999	Ingenika sidehill	3	orange neckband (#18), 2 unclassified	Fraser Corbould
	Ingenika sidehill	1	unclassified	Fraser Corbould
September 7 1999	102.1km on Finlay N Rd	1	adult female	Rich Weir

[a] No data (group size not specified).

[b] Second-hand report.